Saskatchewan
Agriculture, Food
and Rural
Revitalization

ADF

AGRICULTURE DEVELOPMENT FUND

FINAL REPORT

20020219

SELECTION OF ITALIAN AND PROSO MILLETS FOR BIRD SEED OR FORAGE

Funded by: The Agriculture Development Fund

March, 2005
Prepared by: University of Saskatchewan

105-05131/

ADF PROJECT 20020219-24AC

"SELECTION OF ITALIAN AND PROSO MILLET FOR BIRD SEED OR FORAGE"

FINAL REPORT

(April 1, 2003 to February 10, 2005)

Principal Investigator: P. Hucl
Crop Development Centre
University of Saskatchewan

ABSTRACT

A group of 13 Italian millet lines was tested for grain at four sites in replicated trials in 2003 while 11 lines were evaluated at four sites in 2004. Averaged over six trials the Italian millet accessions yielded 50 to 70% more grain than the Proso millet check variety and were, on average, a week later maturing. The Italian millet accessions had smaller seed and lower test weight than the check variety. Of the 13 Italian millet accessions evaluated, two hold promise on the basis of yield and earlier maturity. A collection of 650 Proso millet lines was evaluated for maturity, height and yield. Of 16 lines evaluated in replicated trials in 2004, one warrants further testing. A total of 65 Italian and Proso millet lines were evaluated for forage production in 2004. The combination of cool growing conditions and early fall frost limited the usefulness of the data collected. Golden German millet produced 22 to 59% of the biomass produced by the annual forage oat cultivar 'CDC Baler'. Based on our results relative to the millet control variety, 35 millet accessions warrant further evaluation for annual forage production.

EXECUTIVE SUMMARY

Italian and Proso millet *(Panicum milaceum)* are major components of birdseed mixes but are generally not grown in Saskatchewan because of their later maturities. Millets tend to perform well under high temperature conditions and are physiologically similar to sorghum and corn. Both millet types can be seeded and harvested with conventional equipment. Golden German millet, a form of Italian millet, is used as a forage crop.

An Italian millet (*Setaria italica*) collection consisting of 730 accessions was evaluated at Saskatoon as part of an initial SADF Project (19990357), in 2000 and 2001. Of the 730 accessions, 13 were tested for grain at four sites in replicated trials in 2003 and 11 at four sites in 2004. Averaged over six trials the Italian millet accessions yielded 50 to 70% more grain than the Proso millet check variety and were, on average, a week later maturing. The Italian millet accessions had smaller seed and lower test weights than the check variety. Of the 13 Italian millet accessions evaluated, two hold promise on the basis of yield (01MILL16) and earlier maturity (02MILL1).

Sixteen Proso millet lines selected from a screening of 321 accessions (in 2003) were grown at two sites in 2004. One trial was lost to early fall frost. Of the 16 lines, one appears to warrant further testing as it yielded 85% more grain than the check variety, AC Prairie Gold. A number of earlier-heading lines might merit re-testing.

When the late-heading Italian millets in question were tested forage production in plots in 2004, averaged over four replications, Golden German Millet yielded 340 g/ m^2 of dry matter. This control cultivar did not reach 20% panicle emergence by the time of the August 20th killing frost. The forage oat cultivar CDC Baler headed out in 72 days and produced 576 g/m^2 of dry matter. Of the 17 accessions none yielded better than the forage millet control. However, the high coefficient of variation (CV) for this trial precludes any firm conclusions being drawn. Half of the lines warrant re-testing.

A series of 12 intermediate maturity Italian millets first assessed for grain yield in 2000 and 2001 were assessed for forage production at two sites in 2004. Of the 12 lines, one yielded more biomass than the forage millet control. Some of the lines produced grain at one of the sites. Whether some of these lines could serve as dual purpose millet (i.e. produce enough grain in southern SK for annual forage production) remains to be determined.

Of 36 later-maturing, taller Proso millet lines identified in a 2003 hill nursery, five produced significantly (P=0.05) more biomass than Golden German Millet. It would be worthwhile re-testing some of the Proso millet lines (e.g. n=15) for forage yield and quality.

In conclusion, we determined that earlier-maturing Italian millets can be grown successfully in Saskatchewan for grain production. Based on our base-line agronomic data, an economic feasibility study should be conducted. Should there be interest in commercial production, we initiated breeder seed production of the most promising lines. The main impediment to grain millet production is currently a lack of registered weed control products. Research will be required in the area. The extreme growing conditions in 2004 make it difficult to make meaningful conclusions regarding the forage production of millets. The preliminary results from this project indicate that there is potential to develop forage millets that yield more than Golden German millet. However, the yields of the cool season annual forages are not likely to be approached under cool-wet growing conditions.

A reminder: high experimental error due to the cool growing conditions and uneven stands limits the strength of the conclusions from the 2004 trials.

TECHNICAL REPORT

Objectives and Background to Project

The objectives of the current research project were three-fold:

1. To re-assess early-maturing Italian grain millet lines at multiple sites.
2. To assess later-maturing lines relative to commercially grown cultivars for forage yield.
3. To screen the USDA Proso millet collection for maturity and yield.

Saskatchewan is a major exporter of canaryseed for use in bird (primarily canaries) feed mixtures. The proportion of canaryseed in feed mixtures varies with the bird species being fed. Canaryseed tends to be the most expensive component of the mixture. Millets (eg Proso millet and Italian millet) tend to be used more extensively. Millet prices are less than those of canaryseed (7 cents versus 12 cents/lb). However, the yield of proso millet tends to be 2 to 3 times higher than that of canaryseed under small plot growing conditions. In North Dakota, Italian millet yields are similar to those of proso millet. Italian millet is not produced in Saskatchewan although it constitutes up to 75% of the volume in birdseed mixes for caged exotic birds and budgies. Canada imports $3 million worth of millet from the USA per year. This includes both Italian and Proso millet.

Millets can be seeded and harvested with conventional equipment. Millets are C4 plants and perform well under high temperature conditions and are physiologically similar to sorghum and corn. With the potential for an increasingly warmer climate in Saskatchewan, millet may prove to better adapted than temperate climate cereals in the future. Birdseed is cleaned and processed domestically. The successful introduction of another component of birdseed mixes should result in extra primary processing and packaging.

In a preliminary ADF project we evaluated 700 accessions of Italian millet (*Setaria italica)* for maturity and grain production at Saskatoon, SK. Italian millet is a major component of birdseed mixes but is not grown in Saskatchewan because of its late maturity. The outcome of our exploratory study was that we identified 20 or so lines. Those that were early maturing could be utilized for grain production. Later-maturing lines of *Setaria italica* are utilized for forage production and called "German millet". German millet is about 2-3 weeks later heading than Italian millet and hence too late as a grain crop. Thus, Italian millet and German millet are, in effect, different market types within the same species and are differentiated by maturity differences.

German millet was grown successfully as an annual forage crop in eastern Saskatchewan in 2002 on 30,000 acres.

Standard small plot techniques were used to measure grain yield (13 accessions) and forage and grain yield (27 accessions) along with maturity and other agronomic characteristics on Italian millet. Grain yields were not obtained for two of three forage trials due to an early fall frost in 2004. Sixteen accessions of Proso millet were evaluated for grain yield and 36 were evaluated for forage production.

A.1 Italian millet lines evaluated for grain yield in 2003 and 2004.

Thirteen Italian millet lines which matured at Saskatoon in 2000 and/or 2001 were grown at four sites in 2003. Two of the lines were dropped on the basis of late maturity, leaving 11 lines for evaluation in 2004. The Proso millet cultivar AC Prairie Gold was used as a control. The field trial comprised of a three-replication RCBD grown at the University of Saskatchewan's Seed Farm (SF), Kernen Farm (KCRF), IHARF at Indian Head and at the Swift Current AgriArm site. The four trials were planted in mid to late May in 2003 and 2004. The plots at Saskatoon were 1.2 x 3.6 m in size, consisting of 4 rows on 30 cm spacings. The IH and Swift Current plots were approximately 4 times larger than the Saskatoon plots.

Table 1. Grain yield of selected Italian millet lines and a Proso millet cultivar control at four sites in 2003 and two sites in 2004.

ENTRY	NAME	2003 SF Grain yld	2003 KCRF Grain yld	2003 IH Grain yld	2003 SWCU Grain yld	2003 **Average** Grain yld	2004 SF Grain yld	2004 SWCU Grain yld	**2004 Average Grain yield**	2 yr Average **Grain yield**	Yield %
							kg/ha	kg/ha	kg/ha	kg/ha	ACPG
1	AC Prairie Gold	2201	1040	405	292	**985**	277	958	**617**	862	**100.0**
2	01MILL2	2969	2245	1231	562	**1752**	691	1046	**869**	1457	**169.1**
3	01MILL6	3037	1829	1037	451	**1589**	842	786	**814**	1330	**154.3**
4	01MILL10	3052	1764	1129	497	**1611**	503	788	**645**	1289	**149.5**
5	01MILL15	3068	1478	1293	640	**1620**	641	1074	**858**	1366	**158.4**
6	01MILL16	2949	2164	1253	662	**1757**	571	1219	**895**	1470	**170.5**
7	02MILL1	2705	2252	1016	845	**1705**	301	983	**642**	1350	**156.7**
8	02MILL2	3129	2218	1269	592	**1802**	culled	culled	culled	culled	culled
9	02MILL4	2570	1408	805	511	**1323**	culled	culled	culled	culled	culled
10	02MILL5	3212	1391	568	680	**1463**	652	965	**808**	1245	**144.4**
11	02MILL8	3205	1763	1262	791	**1755**	651	1075	**863**	1458	**169.1**
12	02MILL9	2995	1606	1066	542	**1552**	960	1229	**1095**	1400	**162.4**
13	02MILL10	2826	2004	1241	473	**1636**	394	1042	**718**	1330	**154.3**
14	02MILL11	3435	1469	1025	385	**1579**	924	984	**954**	1370	**159.0**
	Site mean	2954	1760	1043	566		617	1012			
	CV	11.5	18.3	8.9	28.1		16.2	21.3			
	LSD	475	449	130	221		140	302			

Average grain yields (Table 1) for individual trials ranged from an average of 566 kg/ha (Swift Current) to 2954 (Seed Farm) in 2003. In 2004, the range was from 0 kg/ha (Kernen and Indian Head) to 1012 kg/ha (Swift Current). The 2003 Seed Farm site received approximately 100 mm of irrigation in late June. The remaining sites were rain-fed. In 2004, a killing frost on August 20th resulted in no grain being harvested from the Kernen and Indian Head sites. Averaged over all six harvested sites, the highest grain yield was obtained for the Italian millet line 01MILL16. This line yielded 170% of AC Prairie Gold and was similar in days to heading and 8 to 10 days later maturing (Table 2). The Italian millet lines were generally shorter than AC Prairie Gold but higher yielding by 50 to 70%. The yield differential was generally greater in 2003 than in 2004, when all yields were depressed by the cool growing conditions. Millets are C4 plants, and like maize, perform best with higher temperatures. There were approximately 30% fewer Growing Degree Days in 2004 compared to 2003. The Italian millet lines tended to be later maturing (approximately one week) and shorter than the Proso millet control (AC Prairie Gold). The Italian millets had lower test weights (5 to 8 kg/hL) than AC Prairie Gold in 2003 and seed weights that were roughly half those of the control. The differences between the two millet types were more pronounced in 2004 for test and kernel weights.

Since Proso millet is prone to shattering at maturity it is possible that some of yield advantage of the Italian millets is in fact exaggerated.

Table 2. Days to panicle emergence (DPE), days to maturity (DPM), plant height, test weight (TWT) and 1000 kernel weight (Kwt) of selected Italian millet lines and a Proso millet cultivar control in 2003 and 2004.

ENTRY	NAME	2003 DPE days	2004 DPE days	2003 DPM days	2004 DPM days	2003 Height (cm)	2004 Height (cm)	2003 TWT (kg/hl)	2003 Kwt (g)	2004 SF TWT (kg/hl)	2004 SF Kwt (g)
1	AC Prairie Gold	57.3	73.1	98.3	110.0	84.9	80.5	74.2	5.2	70.4	4.8
2	01MILL2	60.9	78.2	102.7	117.5	75.7	69.8	67.3	3.1	56.1	2.0
3	01MILL6	63	77.9	109	115.2	75.6	75.3	67.0	3.0	56.7	2.4
4	01MILL10	65	78.9	109.3	119.7	67.6	62.0	65.8	3.1	53.6	2.2
5	01MILL15	65.1	79.0	107.5	118.3	70.8	70.8	68.7	3.0	53.6	1.9
6	01MILL16	63.7	78.6	108.8	118.2	65.7	64.2	67.4	3.2	53.6	2.2
7	02MILL1	55.7	69.9	97.2	104.8	71.2	70.7	69.2	2.9	63.0	2.5
8	02MILL2	57.1	74.9	103	114.5	72.9	75.5	69.4	2.9	58.3	2.2
9	02MILL4	68.6	culled	109	culled	84	culled	64.3	2.2	culled	culled
10	02MILL5	70.4	culled	109.2	culled	94.6	culled	65.9	2.4	culled	culled
11	02MILL8	61.6	76.9	108.8	117.0	64.6	61.0	67.0	2.9	57.4	2.3
12	02MILL9	61.1	76.1	107.7	114.3	73.6	74.8	68.0	2.7	58.9	2.0
13	02MILL10	66	79.6	108.8	117.3	66.4	65.0	67.5	2.8	49.6	1.9
14	02MILL11	66.2	79.7	108.8	119.3	78.9	68.8	65.3	2.6	51.4	1.9
	# of sites	3	3	2	2	3	2	3	3	3 reps	3 reps

A.2 Proso millet lines for grain:

Sixteen Proso millet lines selected from the 2003 evaluation of 321 accessions were grown in a 2 rep test using a Randomized Complete Block Design . The trial at the Kernen Crop Research Farm (KCRF) was destroyed by frost in late August, 2004. However, data was collected on other traits at that site (Table 3). The CV for yield was very high (57.8%), limiting data interpretation to generalities. Of the 16 lines, one appears to warrant further testing (Trt 5) as it yielded 85% more grain than AC Prairie Gold . A number of earlier-heading lines might merit re-testing.

Table 3. Agronomic performance of selected Proso millet lines at two sites in 2004.

Trt		Grain yield kg/ha SF	DPE days SF	DPE days KCRF	DPM days SF	Height cm SF	Height cm KCRF	Twt kg/hL SF	Kwt mg SF
1	AC Prairie Gold	446	70	80	112	95	82	69.3	4.56
2	04PMIL01	242	75	86	124	76	61	60.3	4.10
3	04PMIL02	181	77	88	125	102	72	56.1	2.78
4	04PMIL03	409	77	91	127	88	63	54.7	4.22
5	04PMIL04	823	73	81	125	103	82	66.8	4.50
6	04PMIL05	149	72	85	112	74	68	65.2	5.18
7	04PMIL06	221	77	89	124	85	60	51.4	4.16
8	04PMIL07	93	72	83	119	95	75	*	4.64
9	04PMIL08	67	78	90	127	116	82	*	2.76
10	04PMIL09	121	77	87	125	92	67	57.8	4.58
11	04PMIL10	47	77	83	117	93	73	*	3.48
12	04PMIL11	174	77	89	116	108	74	64.6	4.12
13	04PMIL12	196	72	83	125	79	75	53.3	4.12
14	04PMIL13	85	75	87	118	98	71	*	3.04
15	04PMIL14	313	78	89	127	94	73	59.7	3.40
16	04PMIL15	121	77	89	112	114	84	*	3.54
17	04PMIL16	159	75	87	125	98	66	54.7	3.46
	CV	57.8							
	LSD	228							

Days to panicle emergence (DPE), days to maturity (DPM), plant height, test weight (Twt) and 1000 kernel weight (Kwt)

A.3 Seed purification of selected Italian millet lines.

Seed purification plots (10 per line were grown at the Kernen Farm in 2003. Purification plots can be used as a source of breeder seed for lines that warrant commercial production, should there be interest from the Special Crops industry. Up to a kg of seed was obtained for individual plots. Individual plots were assessed for days to panicle emergence and physiological maturity as well height. This information was used to determine the within-entry uniformity.

A.4 Evaluation of late-heading Italian millet lines for forage production

Two sets of lines were evaluated under rain-fed conditions at Saskatoon in 2003. The first set of lines consisted of accessions that were initially evaluated in 2000 or 2001. These lines were

considered too late-heading for bird seed production purposes but still produced viable seed, although at a reduced level. Fifty-four lines fit the selection criteria and were grown in single 3.6 m rows spaced 30 cm apart. This nursery was seeded on May 26, 2003. Two rows of Golden German millet were used as checks. The nursery was assessed for days to panicle emergence, maturity date, plant height and grain production (Table 4). Forage yield was not measured in 2003 in order to maximize seed supplies for a replicated forage yield trial in 2004.

The Golden German millet (annual forage millet) control headed-out 81 days after seeding (mid-August). The latest heading accession did so in 75 days (Table 4); the earliest in 56 days. There was a wide variation (two-fold) in plant height for the accessions. The control had a plant height of 137 cm. Seventeen accessions had plant heights greater than 130 cm. Assuming that plant height is correlated with biomass production, these lines were retested in 2004 for forage production. The 17 lines ranged from 69 to 75 days to panicle emergence. For the 54 accessions, there was a correlation of r=0.76** between plant height and DPE and weak correlations between grain yield and the latter traits (circa r=-.20). The grain yield of the accessions ranged from a low of 73 kg/ha to a high of 6171 kg/ha. The grain yield of the 17 taller lines ranged from 73 to 3962 kg/ha compared to 2205 kg/ha for the Golden German millet. However, 14 of 17 lines reached physiological maturity prior to the first killing fall frost while the Golden German millet did not. The seed of the selected lines was assessed for viability at room temperature and at 15 C in a controlled temperature incubator. The germination at 15C varied between 8% and 88% for the selected lines (Table 5). The seeding rates were adjusted for germination and seed weight.

Table 4. Evaluation of Italian millet accessions in rows (2003) for potential annual forage production

		Number	Average	Min	Max
Millet accessions	DPE	54	65.9	56	75
	DPM	25	102.7	111	113
	Height (cm)	54	121.4	92	180
	GY (kg/ha)	54	2544	73	6171

		Average
Golden German Millet		
	DPE	81
	DPM	froze
	Height (cm)	137
	GY (kg/ha)	2205

When the 17 lines in question were tested in plots in 2004, averaged over four reps, Golden German Millet yielded 340 g/m2 of dry matter (Table 5). This control cultivar did not reach 20% panicle emergence (the target sampling stage) by the time of the August 20th frost (F = frozen in Table 5). The forage oat cultivar CDC Baler headed out in 72 days and produced 576 g/m2 of dry matter. For biomass sampling a 0.6 m^2 quadrat was harvested from the centre of each 4.3 m^2 plot. Biomass samples were oven-dried at 80C for 48 hours prior to weighing. Of the 17 accessions none yielded better than the forage millet control. However, the high coefficient of variation (CV) for this trial precludes any firm conclusions being drawn. Based on the LSD value, half of the lines warrant re-testing. This trial was set up as a 6 rep RCBD with four reps harvested for forage and

two for grain. No grain was produced on the two reps designated for that purpose. However, sufficient seed was produced in 2003 should the need for further testing arise.

Table 5. Evaluation of Italian millet accessions selected from 2003 rows for potential annual forage production in plots in 2004 at the Kernen Crop Research Farm

Trt #	NAME		Biomass	Plant Stand	Germination of 2003 seed	DPE
			g/m2	1 to 10	%	days
1	Golden G. Millet		340	8.8	80	F
2	CDC Baler	Forage oat	576	10.0		72.0
3	04FMIL01	PI173803	170	6.7	56	90.4
4	04FMIL02	PI179037	114	4.5	54	95.0
5	04FMIL03	PI473579	105	1.8	77	95.0
6	04FMIL04	Ames 2537	290	9.3	73	90.8
7	04FMIL05	Ames 7802	214	7.8	79	90.7
8	04FMIL06	PI180880	141	7.8	43	92.3
9	04FMIL07	PI261223	219	6.7	59	91.5
10	04FMIL08	PI290460	213	7.3	8	88.0
11	04FMIL09	PI430147	158	6.7	40	92.4
12	04FMIL10	PI458627	94	3.0	84	91.5
13	04FMIL11	PI458631	85	3.0	88	94.0
14	04FMIL12	PI458639	136	5.5	82	93.3
15	04FMIL13	PI458641	89	3.5	6	F
16	04FMIL14	PI458643	158	5.2	50	91.0
17	04FMIL15	PI531435	210	8.0	65	92.5
18	04FMIL16	PI531442	193	7.3	45	92.7
19	04FMIL17	PI531446	225	8.2	63	F
	P value		***	**		
	CV(%)		47.0			
	LSD		184			

The second set of Italian millet lines assessed in 2003 consisted of approximately 140 accessions from the USDA millet collection which were grown in 30 cm hills at Saskatoon. Repeated check hills of Golden German millet were included in the nursery. The results from that nursery are summarized in Table 6. The hills were planted on May 26, 2003. A few lines did not germinate. Of the 141 lines, 17 headed out. Ten of those lines produced some grain. The remaining 121 lines were harvested on September 16th and their biomass dry matter determined after oven-drying at 80C for 72 hours. The control cultivar averaged 187 grams of DM per hill. The 121 accessions ranged from a low of 7 grams to a high of 259 grams DM/hill. Of the 121 accessions, 41 produced biomass levels similar to or higher than the check cultivar. Since these lines did not head out and produce seed it was not possible to re-assess them.

Table 6. Evaluation of Italian millet accessions in hills for potential annual forage production at Saskatoon in 2003.

		Number	Average	Min	Max
Millet accessions	DPE	17	87	61	99
	DPM				
	Height (cm)	17	82.6	64	120
	Biomass (g)	121	128	7	259
Golden German Millet			Average		
	DPE		87.8		
	DPM		froze		
	Height (cm)		83.2		
	Biomass (g)		187		

A series of 12 later maturing Italian millets first assessed for grain yield in 2000 and 2001 were assessed for forage production at two sites in 2004 (Table 7). A four replicate RCBD was used. Of the 12 lines, one line (01MILL17) yielded more biomass than the millet control (Trt 1). The CV's for both sites were high, in part due to uneven and low plant stands. As was the case in the other trials, seeding rates had been adjusted for germination and seed weight. However, the plant stands varied widely at both sites. Some of the lines produced grain at the Seed Farm site. Whether a line such as 01MILL17 could serve as dual purpose millet (ie produce enough grain in southern SK for annual forage production) remains to be determined.

Table 7. Evaluation of intermediate maturity Italian grain millets for forage production at twos sites in 2004.

trt.	NAME	SF Biomass g/m2	KCRF Biomass g/m2	average	SF Plant Stand 1 to 10	KCRF Plant Stand 1 to 10	SF DPE days	KCRF DPE days	SF DPM days	SF height cm
1	Golden G. Millet	295	265	**280**	9.5	6.8	86.0	F	F	84
2	CDC Baler	530	526	**528**	10.0	10.0	64.5	72.0	116	111
3	00MILL2	110	71	**91**	3.8	2.0	83.5	90.0	126	79
4	00MILL4	237	84	**161**	6.0	5.3	78.0	89.6	115	94
5	00MILL5	121	67	**94**	3.3	3.3	83.0	91.0	126	84
6	00MILL8	212	168	**190**	9.3	8.3	70.0	84.2	117	77
7	00MILL11	73	73	**73**	3.3	1.5	83.0	89.5	126	77
8	01MILL11	169	107	**138**	7.0	4.5	72.0	86.5	105	105
9	01MILL13	89	146	**117**	5.8	4.0	70.0	86.6	117	75
10	01MILL17	412	215	**313**	9.0	5.8	79.0	91.5	115	104
11	01MILL18	240	171	**205**	8.5	6.5	78.0	89.3	112	104
12	01MILL20	177	119	**148**	6.8	3.5	80.5	90.4	120	91
	P value	***	***							
	CV(%)	38.4	50.5							
	LSD	188	187							

		SF Grain yld kg/ha	SF TWT (kg/hl)	SF Kwt (g)
1	German G. Millet	13	F	F
2	CDC Baler	2920	42.6	40.6
3	00MILL2	12	F	F
4	00MILL4	599	55.0	1.9
5	00MILL5	50	F	F
6	00MILL8	556	56.4	2.4
7	00MILL11	29	F	F
8	01MILL11	495	46.9	2.1
9	01MILL13	87	F	F
10	01MILL17	724	44.4	1.7
11	01MILL18	1430	58.1	2.3
12	01MILL20	91	42.3	1.9

A.5. Evaluation of Proso millet accessions from the USDA collection in hills in 2003 and 2004

The objective of this sub-project was to pre-screen the proso millet collection for days to panicle emergence and maturity, plant height and grain yield in two steps with the most promising lines being subsequently yield-tested in plots. The first set was screened in 2003 (Table 8). The nursery was hand-planted on May 26, 2003. A small number (<10) of lines did not germinate. The remaining 321 lines were assessed for days to panicle emergence, maturity, height, grain yield and panicle density. Nearly all the lines headed by the first killing fall frost in 2003. 51 reached maturity and 105 set seed. Compared to the check, AC Prairie Gold, there was a very high level of genetic diversity in the collection. There were lines that were nearly twice as tall or yielding significantly higher, based on unreplicated hills. Of the 105 accessions that produced grain, 72 had

yields/hill at least one standard deviation (12.3 g/hill) higher than the check. These results suggested that we should be able to i) select higher yielding millets for grain and ii) select taller, later heading millets for forage. Sixteen of the higher yielding, early maturing accessions were yield tested in plots in 2004 (Table 3). Of the later-maturing, taller lines, 36 were evaluated for forage yield in 2004 (Table 9).

The remainder of the Proso millet collection was seeded out in 2004 using the same protocol as in 2004. The hill nursery was seeded on May 27 at the University of Saskatchewan North Seed Farm. Of the 320 lines seeded, 70 headed out. Of the 70 lines that headed out, 24 were similar (within two days) in heading date to AC Prairie Gold. None of the lines (including the AC Prairie Gold controls) produced seed in 2004. As a result no meaningful information was obtained in 2004.

Table 8. Evaluation of Proso millet accessions in hills in 2003

		Number	Average	Min	Max
Proso Millet accessions	DPE (days)	317	77.7	52	115
	DPM (days)	51	114.2	107	117
	Height (cm)	321	129.6	35	205
	GY (g/hill)	105	57.4	8.2	152.6
AC Prairie Gold			Average		
	DPE	17	52		
	DPM	17	113.5		
	Height (cm)	16	83.6		
	GY (g/hill)	18	26.2		

Of the later-maturing, taller Proso millet lines identified in the 2003 hill nursery, 36 were evaluated for forage yield at a single site in 2004 (Table 9). Of the 36 lines, five produced significantly ($P=0.05$) more biomass than Golden German Millet. Plant stand varied significantly for the lines, despite seeding rate adjustments for seed weight and germination. Biomass was moderately correlated with plant stand ($r=0.71^{**}$). It would be worthwhile re-testing some of the Proso millet lines (eg n=15) for forage yield and quality.

Table 9. Forage yield of late heading Proso millet lines grown at the Kernen Crop Research Farm in 2004.

Trt#	NAME	Proso	Biomass g/m2	Plant Stand 1 to 10	DPE days
1	Golden G. Millet		113	5.7	*
2	CDC Baler	Forage oat	509	10.0	72
3	04FMIL18	361 (PI 163298)	166	8.7	*
4	04FMIL19	363 (PI 170586)	112	6.0	*
5	04FMIL20	365 (PI 170588)	197	8.7	95
6	04FMIL21	367 (PI 170590)	89	5.3	95
7	04FMIL22	369 (PI 170592)	175	7.3	*
8	04FMIL23	373 (PI 170596)	276	7.7	*
9	04FMIL24	375 (PI 170600)	109	5.7	*
10	04FMIL25	377 (PI 170602)	303	9.3	*
11	04FMIL26	381 (PI 173002)	199	9.3	95
12	04FMIL27	383 (PI 173750)	174	8.7	*
13	04FMIL28	389(PI 175795)	153	5.7	*
14	04FMIL29	393 (PI 176655)	168	9.3	94
15	04FMIL30	396(PI 177480)	139	8.7	*
16	04FMIL31	400(PI 178991)	280	9.0	*
17	04FMIL32	402(PI 178993)	132	6.3	*
18	04FMIL33	404(PI 179380)	176	8.0	*
19	04FMIL34	410(PI 179387)	116	7.0	*
20	04FMIL35	414(PI 179391)	297	9.0	94
21	04FMIL36	428(PI 204905)	270	8.7	*
22	04FMIL37	430(PI 207663)	124	6.7	*
23	04FMIL38	436(PI 212317)	148	7.7	*
24	04FMIL39	440(PI 220392)	165	8.3	*
25	04FMIL40	451(PI 223791)	99	6.3	*
26	04FMIL41	455(PI223795)	190	7.0	*
27	04FMIL42	485(PI 269958)	182	8.3	*
28	04FMIL43	487(PI 269960)	178	9.0	95
29	04FMIL44	489(PI 289320)	94	7.3	*
30	04FMIL45	523(PI 365840)	209	8.7	94
31	04FMIL46	525(PI 365842)	193	8.7	94
32	04FMIL47	249(PI 463397)	22	5.0	*
33	04FMIL48	263(PI 463411)	184	7.3	*
34	04FMIL49	265(PI 463413)	142	7.0	*
35	04FMIL50	321(PI 463471)	166	7.7	*
36	04FMIL51	323(PI 463473)	197	9.0	*
37	04FMIL52	337(PI 463487)	108	7.3	*
38	04FMIL53	644(PI 531426)	211	7.7	92
	P value		**	**	
	CV(%)		42.2		
	LSD		152		

In conclusion, we determined that earlier-maturing Italian millets can be grown successfully in Saskatchewan for grain production. Based on our base-line agronomic data, an economic feasibility study should be conducted. If there is interest in commercial production, we have initiated breeder seed production of the most promising lines. The main impediment to grain millet production is currently a lack of registered weed control products. Research will be required in that area. The extreme growing conditions in 2004 make it difficult to make meaningful conclusions regarding the forage production of millets. The preliminary results from this project indicate that there is potential to develop forage millets that yield more than Golden German millet. However, the yields of the cool season annual forages are not likely to be approached under cool-wet growing conditions as experienced in 2004.

Item (d). **Personnel -**

V. Spilchuk (May 1, 2003 – August 31, 2003) – 100%
(Summer Assistant)

J. Bushman (October 1, 2003 – December 1, 2003) -100%
(Tech. Assistant)

S. Campbell (October 1, 2003 – December 1, 2003) -100%
(Tech. Assistant)

S. Barr (January 1, 2004 – April 30, 2004) -100%
(Tech. Assistant)

A. Bathgate (May 1, 2004 – August 31, 2004) -100%
(Summer Assistant)

C. Saganski (September 1, 2004 – December 31, 2004) -100%
(Tech. Assistant)

L. Ehman (December 1, 2004 – January 31, 2005) -100%
(Technician)

Other contributors:

P. Hucl (April 1, 2003 – January 31, 2005) -1.5%

Item (e) **Equipment**. None purchased for this project.
Item (f) **Project Developed Materials**: Nil.
Item (g) **Project photos:** Nil
Item (h) **Acknowledgements:** SADF was acknowledged at a Canaryseed Association of Canada meeting (March 2004) where the 2003 results were described.